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THE EFFECT OF PLANT GROWTH REGULATORS AND SCION CULTIVARS ON THE BREADFRUIT-CHATAIGNE GRAFT UNION

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ABSTRACT: Grafting breadfruit (*Artocarpus altilis*) on chataigne (*Artocarpus camansi*) rootstock has the potential to be used as a commercial propagation method to increase the supply of breadfruit within the Caribbean and the environmental distribution of breadfruit trees. However, variable success in grafting these two species has been reported and the impact of important factors on successful grafting has not been elucidated. This study aimed to evaluate the effect of the plant growth regulators - Indole butyric acid (IBA) and 6-benzylaminopurine (BAP) - and the cultivar of the scion on the breadfruit-chataigne graft union. Scion was taken from three breadfruit cultivars 'Yellow' and 'White' from Trinidad and Tobago, and 'JA1', a Jamaican accession, and from chataigne, the control. IBA treatments (100 ppm and 200 ppm) and BAP treatment (200 ppm) negatively affected ($P < 0.05$) length of survival of the newly grafted plants compared with the control (0 ppm). Grafted plants with 'White' and chataigne scion cultivars generally survived longer ($P < 0.05$) than grafts with other cultivars. Therefore, genetic differences among the breadfruit scions clearly influenced successful grafting of breadfruit on chataigne rootstock. The basis of these differences and the effects of PGRs on the grafting these species require further investigation.

Keywords: *Artocarpus altilis*, *Artocarpus camansi*, propagation, grafting.

Introduction

The breadfruit (*Artocarpus altilis*), with an estimated potential productivity of 50 t/ha/yr (Roberts-Nkrumah, 1998) and good nutritional value (Graham and Negron de Bravo, 1981), especially as a local source of carbohydrates, has significant potential for commercial production. However, constraints to commercialization include a decline disease of mature trees and limitations associated with vegetative propagation.

Breadfruit decline was reported in the Pacific and the Caribbean (Zaiger and Zentmyer, 1966; Trujillo, 1971; Weir et al., 1982; Hodges and Tenario, 1984; Coates-Beckford and Pereira, 1992). Within the Caribbean, weakly pathogenic organisms were associated with affected trees (Coates-Beckford and Pereira, 1992). Trujillo (1971) suggested that the decline could not be attributable entirely to minor pathogens, but must also involve a f environmental factors including drought and saline ground water. In a recent survey of breadfruit and chataigne (*A. camansi*) in Trinidad and Tobago, it was noticed that tree decline was more prevalent in wetter regions where the breadfruit tree population was higher than in the drier areas, and that chataigne was much less affected.

Due to seedlessness, breadfruit in the Caribbean can be propagated only vegetatively. The most common methods produce adventitious shoots that develop on shallow roots and supply relatively limited quantity of young trees. Chataigne, however, is seeded and can produce a larger number of new plants with a tap root system. Grafting breadfruit on chataigne rootstocks to confer tolerance to tree decline and to produce larger amounts of planting material considerably improves the prospects for commercialization. One remaining obstacle is the reported highly variable level of success achieved by grafting these two closely-related species (Zerega et al., 2004).

There are several factors influencing successful grafting, among which are cultivar and plant growth regulators (Hartmann et al. 2011). Among reports of grafting breadfruit onto chataigne rootstock, Medagoda and Chandrarathna (2007) obtained a high success rate of 83% on 45-day-old rootstock. However, they cited Wester, as reporting that attempts at grafting these species had failed. Solomon Jr. and Roberts-Nkrumah (2008) evaluated the effect of rootstock age, grafting technique and scion cultivar on grafting breadfruit on chataigne. They reported a maximum success rate of only 28% and concluded that, under the influence of plant growth regulators, the physiological state of the parent plants may play a role in the success of grafting these two species.

The objective of this study was to evaluate the effect of plant growth regulators and the cultivar of the scion on successful grafting of breadfruit on chataigne rootstock.

Materials and Methods

Three studies were conducted at the University of the West Indies, St. Augustine campus, Trinidad and Tobago, W.I., using planting material from the breadfruit germplasm at the University Field Station. The effects of plant growth regulators (PGR) and cultivar of scion on the length of survival of grafts were evaluated in three individual experiments. All experiments used top wedge grafting on 6-week-old chataigne seedlings (Solomon Jr. and Roberts-Nkrumah, 2008).

In October 2008, an experiment was conducted to examine the effect of the cytokinin, 6-benzylaminopurine (BAP), on the length of survival of the grafted scion. The variables were scion cultivar (three breadfruit cultivars ‘Local Yellow’, ‘Local White’ and ‘JA1’ and chataigne as the control) and BAP at 0 ppm and 200 ppm. In a completely randomized design, consisting of 10 replicates each of the eight treatment combinations was used. In December 2008, using a similar experimental design, a lower concentration of BAP (50 ppm) and control (0 ppm) was examined. The experiment conducted in October 2008 used chataigne seedlings, which ranged between 4.8 mm and 6 mm in stem diameter. These seedlings were grown in a soil mixture in potting bags, whereas, in subsequent trials, seedlings were grown in Promix™ in Ray Leach seedling cone-tainer cells.

In March 2009 the effect of the auxin, Indole butyric acid (IBA), was evaluated. The experimental design consisted of a treatment combination of the same four scion cultivars as in the previous experiments and three concentrations (0, 100 and 200 ppm) of IBA, with 10 replicates in a completely randomized design. In all three experiments approximately 4 ml of plant growth regulators was applied as a spray to coat the scion evenly immediately after grafting. The scion material consisted of axillary shoots with lobed leaves and intact terminal meristem. The length and diameter of the scion ranged between 5 cm and 10 cm, and 6 and 8 mm respectively. The grafted plants were covered with clear plastic bags, which were tied just below the graft union and placed under shade in greenhouse.

Grafting success was measured by the length of survival of the respective grafted scion cultivar in all experiments. Analysis of variance was conducted using General Linear Model (Minitab® 16) and mean differences were analysed using Least Significant Differences in the Statistical Package for Social Science software.

Results and Discussion

Effect of Plant Growth Regulators

In the October 2008 experiment, the grafted scions in the control treatment (0 ppm BAP) survived longer ($P < 0.05$) than those in the 200 ppm BAP treatment (Table 1). Although some grafted scions survived for almost 8 weeks, the plants tended to topple at the soil level at the point of attachment of the cotyledon to the rootstock axis and the scion eventually died. This might be a result of the planting method and planting medium, since in subsequent experiments with cone-tainer established seedlings, the surviving grafted scions showed no toppling.

Table 1. Effect of BAP on the length of survival (weeks) of breadfruit and chataigne scions at eight weeks after grafting- October 2008

	BAP Treatments		
Scion Cultivar	0 ppm	200 ppm	Cultivar Mean
'Yellow'	2.6	2.8	2.7 d[1] ± 0.4
'White'	7.8	5.0	6.4 a ± 0.43
'JA1'	4.9	3.6	4.3 c ± 0.53
Chataigne	6.8	4.2	5.5 b ± 0.75
BAP Mean	5.5 a ± 0.5	3.9 b ± 0.5	

[1] Means followed by different letters are significantly ($P < 0.05$) different by LSD.

Mean length of survival period of grafted scions was less than two weeks and there was no significant difference in length of survival between BAP treatments in the December 2009 experiment (Table 2). In the March 2009 experiment, the length of survival of the grafted scions declined as IBA concentration increased with those in the control treatment surviving significantly ($P < 0.05$) longer than those treated with 200 ppm IBA (Table 3). The mean length of survival period was also less than two weeks.

Table 2. Effect of BAP on the length of survival (weeks) of breadfruit and chataigne scions at four weeks after grafting- December 2008

Scion Cultivar	BAP Treatments		Cultivar Mean
	0 ppm	50 ppm	
'Yellow'	0.9	1.0	0.9 b ± 0.12
'White'	0.9	1.1	1.0 b ± 0.14
'JA1'	1.4	1.0	1.2 b ± 0.13
Chataigne	3.4	2.9	3.2 a ± 0.21
BAP Mean (NS[1])	1.7 ± 0.16	1.5 ± 0.15	

[1]NS, means are not significantly ($P > 0.05$) different by LSD.

Table 3. Effect of IBA on the length of survival (weeks) of breadfruit and chataigne scions at four weeks after grafting- March 2009

Scion Cultivar	IBA Treatments			Cultivar Mean
	0 ppm	100 ppm	200 ppm	
'Yellow'	1.3	0.8	1.1	1.1 c[1] ± 0.16
'White'	2.4	2.4	1.8	2.2 a ± 0.15
'JA1'	1.7	1.5	1.1	1.4 b,c ± 0.18
Chataigne	2.0	2.1	1.1	1.7 b ± 1.26
IBA Mean	1.9a,b[2] ± 0.23	1.7b,c ± 0.23	1.3 c ± 0.23	

[1]Means in the same column followed by different letters are significantly ($P < 0.05$) different by LSD.
[2] Means in the same row followed by different letters are significantly ($P < 0.05$) different by LSD.

It was reported that auxins and cytokinins play major roles in the development of the graft union (Aloni, 1993; Andrews and Marquez, 1993; Wyzgolik and Piskornik, 2001). Two possible factors that might have accounted for longer survival by the scion material in the control treatment than those treated with PGRs. Firstly, since there is a close relationship between auxin and cytokinin in the development of the graft union (Aloni, 1993), the concentrations of the applied BAP might have been too high and disrupted the cytokinin:auxin ratio required for success, therefore, the unions failed earlier. Secondly, Wyzgolik and Piskornik (2001) reported that auxins must be continuously supplied to the scion after grafting because auxin-degrading enzymes accumulate at the cut surface of the graft union. In this study, a single application of auxin was made, which might not have been sufficient to counteract the effect of these auxin-degrading enzymes.

Effect of Scion Cultivar

Cultivars differed ($P < 0.05$) in the mean length of survival of grafted scions in the October 2008 experiment (Table 1). 'White' was the longest surviving scion, followed by chataigne, whereas in October 2008 'Yellow' had the shortest survival time. The survival of scion cultivars, 'Yellow', 'JA1', 'White' and chataigne, at eight weeks after grafting was 5, 10, 15 and 15 %, respectively.

There were no significant differences among breadfruit cultivars in the mean length of the survival period in the December 2008 experiment. However, the grafted chataigne scions survived significantly longer than the breadfruit scions (Table 2). At the fourth week after grafting, the percentage of surviving scions of the breadfruit cultivars and chataigne was 0 and 72 %, respectively.

The scion of 'White' in the March 2009 experiment survived longer ($P < 0.05$) than those of all other cultivars, including chataigne, which ranked second in the length of survival, while there were no significant ($P < 0.05$) difference between 'JA1' and chataigne and 'Yellow' and 'JA1' (Table 3). The survival of the scion cultivars four weeks post grafting was 3, 43, 20 and 26 % for 'Yellow', 'White', 'JA' and chataigne, respectively.

Therefore, genotype emerged as a significant factor in all three experiments and the basis for these differences need further investigations. However, based on the differences in length of survival period when grafting was conducted at different times of the year, genotype may not be the only important factor that influenced successful grafting breadfruit on chataigne rootstock. Solomon Jr. et al. (2012) showed that the time of year that the scion material was collected and the post-grafting environment were major factors contributing to grafts with a long survival period and high percentage success. This was consistent with other studies that showed that time of year influences auxin concentrations and cambial activity (Hartmann et al., 2011).

Conclusion

The genotype of the scion was clearly a significant factor that influenced successful grafting of breadfruit scion on chataigne with 'White' scions generally being the most successful and those of 'Yellow' the least successful among the breadfruit scion cultivars that were evaluated. Application of cytokinin and auxin to the scion of grafted plants negatively affected survival. Since these experiments were conducted at different times of the year, further investigations are required to explain the results and to identify how time of year during which the scion materials is collected affects successful union.

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